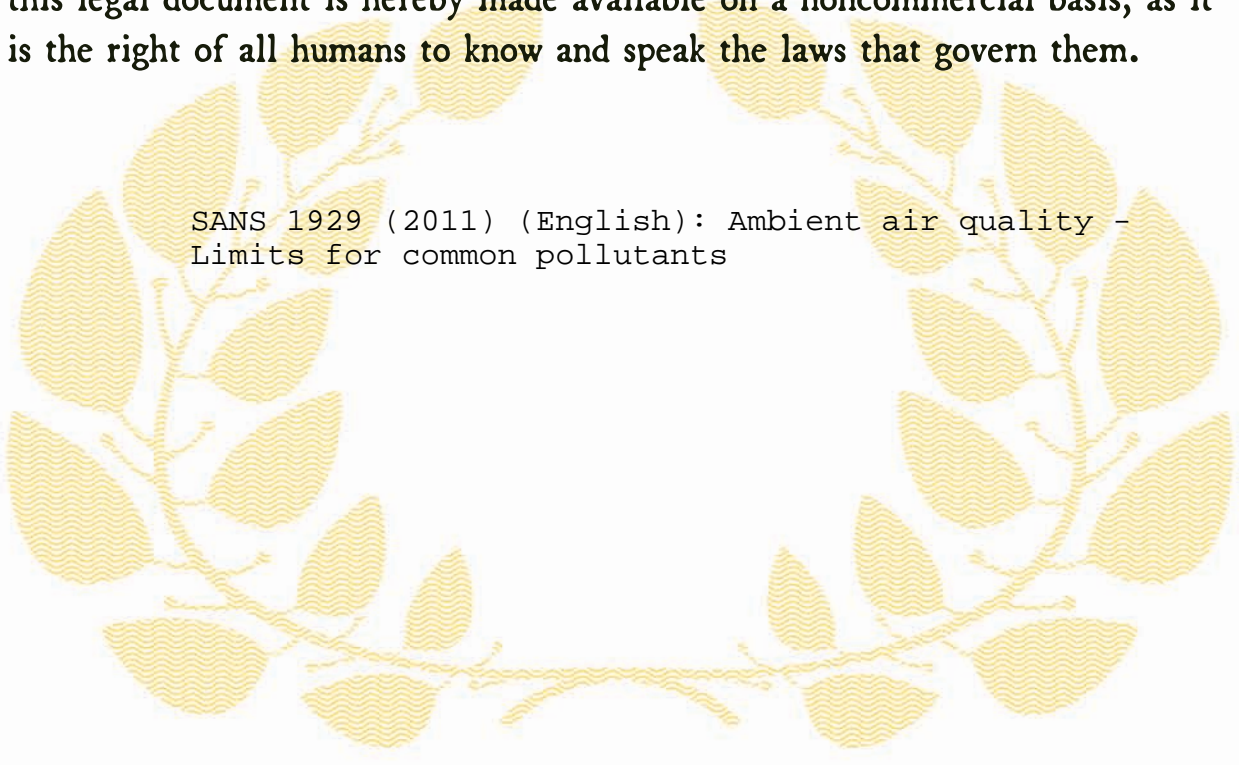




Republic of South Africa

EDICT OF GOVERNMENT

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SANS 1929 (2011) (English): Ambient air quality -
Limits for common pollutants



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SOUTH AFRICAN NATIONAL STANDARD

Ambient air quality — Limits for common pollutants

SANS 1929:2011
Edition 2

Table of changes

Change No.	Date	Scope

Foreword

This South African standard was approved by National Committee SABS TC 146, *Air quality*, in accordance with procedures of the SABS Standards Division, in compliance with annex 3 of the WTO/TBT agreement.

This document was published in December 2011.

This document supersedes SANS 1929:2005 (edition 1.1).

This document is referenced in the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004).

Reference is made in the introductory paragraph of clause 3 to the “relevant national legislation”. In South Africa this means the National Framework for Air Quality Management in the Republic of South Africa as contemplated in section 7 of the National Environmental Management: air Quality Act, 2004 (Act No. 39 of 2004).

Reference is made in 3.1.4 to the “relevant national legislation”. In South Africa this means the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993).

Reference is made in 3.1.14, 4.2.1 and 4.2.2 to the “relevant national legislation”. In South Africa this means the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004).

Reference is made in 3.1.15.1 to the “relevant national legislation”. In South Africa this means the Local Government: Municipal Structures Act, 1998 (Act No. 117 of 1998).

Reference is made in 3.1.15.2 to the “relevant national legislation”. In South Africa this means section 103 of the Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996).

Annexes A, B and E form an integral part of this document. Annexes C, D, F and G are for information only.

Introduction

The National Framework for Air Quality Management in South Africa makes provision for the establishment of air quality objectives for the protection of human health and the environment as a whole. Such air quality objectives include limit values, alert thresholds and target values. Margins of tolerance, time frames for achieving compliance with limit values and permissible frequencies of exceeding limit values are determined to enable the implementation of limit values for the purpose of air quality management and planning. These values are based on assessments that establish the ambient concentrations of prioritized pollutants, and evaluate the technical feasibility, economic viability and social and political acceptability of implementing measures to reduce and maintain air quality within limit values.

The numerical values for limit values, alert thresholds and target values are based on the findings of work carried out by international scientific groups active in the field, taking into account the wealth of local knowledge and relevant local conditions.

Although the National Framework makes provision for establishing air quality objectives for the protection of human health and the environment, it stipulates that limit values are initially set to protect human health. The setting of such limit values represents the first step in a process to manage air quality and initiate a process to ultimately achieve air quality that is not harmful to health and wellbeing nationally. The limit values presented in this standard can therefore not be viewed in isolation, but should be seen as one part of an air quality management programme.

The limit values will also be revised in future to address impacts on other components of the environment such as vegetation and ecosystems, and other pollutants of concern may also be included.

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Ambient air quality — Limits for common pollutants

1 Scope

This standard gives limit values for common air pollutants to ensure that the negative effects of such pollutants on human health are prevented or reduced. Limit values given in this standard are expressed for common pollutants as are permissible frequencies by which limit values may be exceeded.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. Information on currently valid national and international standards can be obtained from the SABS Standards Division.

ASTM D1739, *Standard test method for the collection measurement of dustfall (settleable particulate matter)*.

EN 12341, *Air Quality – Determination of the PM₁₀ fraction of suspended particulate matter – Reference method and field test procedure to demonstrate reference equivalence of measurement methods*.

ISO 4224, *Ambient air – Determination of carbon monoxide – Non-dispersive infrared spectrometric method*.

ISO 5725-1, *Accuracy (trueness and precision) of measurement methods and results – Part 1: General principles and definitions*.

ISO 6767, *Ambient air – Determination of the mass concentration of sulfur dioxide – Tetrachloromercurate (TCM)/pararosaniline method*.

ISO 7996, *Ambient air – Determination of the mass concentrations of nitrogen oxides – Chemiluminescence method*.

ISO 9855, *Ambient air – Determination of the particulate lead content of aerosols collected on filters – Atomic absorption spectrometric method*.

ISO 13964, *Air quality – Determination of ozone in ambient air – Ultraviolet photometric method*.

3 Definitions and abbreviations

For the purposes of this document, the definitions and abbreviations given in the relevant national legislation (see foreword) and the following apply.

3.1 Definitions

3.1.1

agglomeration

area with a population of 250 000 or more inhabitants or, where the population is less than 250 000 inhabitants, a population density per square kilometre that justifies the need for ambient air quality to be assessed and managed

3.1.2

alert threshold

levels of ambient air quality where pre-emptive governance interventions are triggered that provide an adequate intervention development buffer between air that is considered harmful and air that is not considered harmful to health and wellbeing

3.1.3

ambient air

outdoor air in the troposphere, excluding air regulated by the relevant national legislation (see foreword) , where air quality is determined in accordance with this standard

3.1.4

assessment

method that is used to measure, calculate, predict or estimate the level of a pollutant in the ambient air

3.1.5

average period

period over which the average value is determined

3.1.6

data capture

ratio of the time for which the instrument produces valid data, to the time for which the statistical parameter or aggregate value is calculated

3.1.7

level

concentration of a pollutant in ambient air or the mass deposition thereof on surfaces over a given time

3.1.8

limit value

level that is fixed on the basis of scientific knowledge, with the aim of reducing harmful effects on human health, wellbeing or the environment, that is attained within a given compliance period and that does not exceed the number of permissible exceedances once attained

3.1.9

lower assessment threshold

99th percentile pollutant levels that represent a pollutant value below 50 % of all limit values, taking into account limit values for all periods which have been used to derive averages

3.1.10

particulate matter (PM₁₀)

substance that passes through a size-selective inlet with a 50 % efficiency cut-off at 10 µm aerodynamic diameter

3.1.11

pollutant

substance that is introduced directly or indirectly by man into the ambient air and that is likely to have harmful effects on human health, wellbeing or the environment

3.1.12

target value

aspirational level that is based on current scientific knowledge, with the aim of minimizing or avoiding harmful effects on human health, wellbeing or the environment

3.1.13

time coverage

percentage of the time that is considered for setting the threshold value during which the pollutant is measured

3.1.14

upper assessment threshold

99th percentile pollutant levels that represent a pollutant value exceeding 70 % of a limit value, taking into account limit values for all periods which have been used to derive averages

3.2 Abbreviations

EC: European Commission

GEP: good engineering practice

VOC: volatile organic compound

4 Limits for common pollutants

4.1 General

4.1.1 It is recognized that, although national limit values laid down primarily aim at the protection of human health, these limit values might be revised in future to address impacts on other components of the environment such as vegetation and ecosystems.

4.1.2 Concentrations shall be expressed at a standardized temperature of 25 °C and a pressure of 101,3 kPa.

4.1.3 Where test methods are specified, any other method that can be demonstrated to give equivalent results may be used.

4.1.4 Compliance with the limit values shall be at 99 % of each average period specified in this standard.

4.2 Provisions for progressive compliance with the standards

4.2.1 Compliance with the standards shall be on the date of publication in terms of the relevant national legislation (see foreword).

4.2.2 Municipalities that do not comply with these standards shall be required to develop and implement an air quality management plan, as required in terms of the relevant national legislation (see foreword) to progressively meet compliance within the prescribed time frame.

4.3 Sulfur dioxide (SO₂)

NOTE For the purposes of this standard “sulfur” is deemed to be equivalent to “sulphur”.

4.3.1 The limit values, average periods and number of permissible exceedances for sulfur dioxide are stipulated in table 1.

Table 1 — Limits for SO₂

1	2	3
Average period	Concentration µg/m ³	Frequency of exceedances
10 min	500	526
1 h	350	88
24 h	125	4
1 year	50	0

4.3.2 The reference method for the analysis of SO₂ shall be the tetrachloromercurate(TCM)/ pararosaniline method in accordance with ISO 6767.

4.4 Nitrogen dioxide (NO₂)

4.4.1 Limit values, average periods and number of permissible exceedances for nitrogen dioxide are stipulated in table 2.

Table 2 — Limits for NO₂

1	2	3
Average period	Concentration µg/m ³	Frequency of exceedances
1 hour	200	88
1 year	40	0

4.4.2 The reference method for the analysis of nitrogen dioxide shall be ISO 7996.

4.5 Carbon monoxide (CO)

4.5.1 The limit values, average periods and number of permissible exceedances for carbon monoxide are stipulated in table 3.

Table 3 — Limits for CO

1	2	3
Average period	Concentration mg/m ³	Frequency of exceedances
1 h	30	88
8 h (calculated on 1-hourly averages)	10	11

4.5.2 The maximum daily 8-hourly mean concentration shall be selected by examining 8-hourly running averages, calculated from hourly data and updated each hour. Each 8-hourly average so calculated shall be assigned to the day on which it ends, thus, the first calculation period for any one day will be the period from 17:00 on the previous day to 01:00 on that day. The last calculation period for any one day shall be the period from 16:00 to 24:00 on that day.

4.5.3 The reference method for analysis of CO shall be ISO 4224.

4.6 Particulate matter (PM₁₀)

4.6.1 The limit values, average periods and number of permissible exceedances for particulate matter (PM₁₀) are stipulated in table 4.

Table 4 — Limits for PM₁₀

1	2	3
Average period	Concentration µg/m ³	Frequency of exceedances
Interim		
24 h	120	4
1 year	50	0
Target		
24 h	75	4
1 year	40	0

4.6.2 With regard to the setting of limit values for particulate matter, the following shall be recognized:

- a) different types of particles can have different harmful effects on human health;
- b) there is evidence that risks to human health associated with exposure to anthropogenic PM₁₀ are higher than risks associated with exposure to naturally occurring particles in ambient air; and
- c) insofar as they relate to PM₁₀, action plans and other reduction strategies should aim to reduce concentrations of fine particles as part of the total reduction in concentrations of particulate matter.

4.6.3 The reference method for the determination of the PM₁₀ fraction of suspended particulate matter shall be EN 12341.

4.7 Particulate matter (PM_{2.5})

4.7.1 The limit values, average periods and number of permissible exceedances for particulate matter (PM_{2.5}) are stipulated in table 5.

Table 5 — Limits for PM_{2.5}

1	2	3
Average period	Concentration µg/m ³	Frequency of exceedances
24 h	65	
24 h	40	
24 h	25	
1 year	25	
1 year	20	
1 year	15	

4.7.2 The reference method for the determination of the PM_{2.5} fraction of suspended particulate matter shall be EN 14907.

4.8 Ozone (O₃)

4.8.1 Limit value, average period and number of permissible exceedances for ozone are stipulated in table 6.

Table 6 — Limit for O₃

1	2	3
Average period	Concentration µg/m ³	Frequency of exceedances
8 h (running)	120	11

4.8.2 The maximum daily 8-hourly mean concentration shall be selected by examining 8-hourly running averages, calculated from hourly data and updated each hour. Each 8-hourly average so calculated shall be assigned to the day on which it ends, thus, the first calculation period for any one day shall be the period from 17:00 on the previous day to 01:00 on that day. The last calculation period for any one day shall be the period from 16:00 to 24:00 on that day.

4.8.3 The reference method for the analysis of ozone shall be the UV photometric method as described in ISO 13964.

4.9 Lead (Pb)

4.9.1 The limit value, average period and number of permissible exceedances for lead are stipulated in table 7.

Table 7 — Limits for Pb

1	2	3
Average period	Concentration $\mu\text{g}/\text{m}^3$	Frequency of exceedances
1 year	0,5	0

4.9.2 The reference method for the analysis of lead shall be ISO 9855.

4.10 Benzene (C_6H_6)

4.10.1 Limit values, average period and number of permissible exceedances for benzene are stipulated in table 8.

Table 8 — Limits for C_6H_6

1	2	3
Average period	Concentration $\mu\text{g}/\text{m}^3$	Frequency of exceedances
Interim		
1 year	10	0
Target		
1 year	5	0

4.10.2 The reference methods for the sampling and analysis of benzene shall either be EPA compendium method TO-14 A or method TO-17.

4.11 Dust deposition

4.11.1 The four-band scale that shall be used in the evaluation of dust deposition is stipulated in table 9.

NOTE Dust deposition rates are expressed in units of milligrams per square metre per-day over a 30-day average period.

4.11.2 The target, action and alert thresholds for ambient dust deposition are stipulated in table 10.

4.11.3 Dustfalls that exceed the specified rates but that can be shown to be the result of some extreme weather or geological event shall be discounted for the purpose of enforcement and control. Such an event might typically result in excessive dustfall rates across an entire metropolitan region, and not be localized to a particular operation. Natural seasonal variations, for example the naturally windy months each year, will not be considered extreme events for this definition.

4.11.4 The reference method for measuring dustfall shall be ASTM D1739.

Table 9 — Four-band scale evaluation criteria for dust deposition

1	2	3	4
Band number	Band description label	Dustfall rate, D ($\text{mg}/\text{m}^2 \cdot \text{day}^{-1}$, 30-day average)	Comment
1	Residential	$D < 600$	Permissible for residential and light commercial
2	Industrial	$D \leq 1\,200$	Permissible for heavy commercial and industrial.
3	Action	$1\,200 < D \leq 2\,400$	Requires investigation and remediation if two sequential months lie in this band, or more than three occur in a year
4	Alert	$D > 2\,400$	Immediate action and remediation required following the first incidence of the dustfall rate being exceeded. Incident report to be submitted to the relevant authority

Table 10 — Target, action and alert thresholds for dust deposition

1	2	3	4
Level	Dustfall rate, D ($\text{mg}/\text{m}^2 \cdot \text{day}^{-1}$, 30-d average)	Average period	Permitted frequency of exceeding dustfall rate
Target	300	Annual	
Action residential	600	30 days	Three within any year, no two sequential months
Action industrial	1 200	30 days	Three within any year, not sequential months
Alert threshold	2 400	30 days	None. First incidence of dustfall rate being exceeded requires remediation and compulsory report to the relevant authorities

5 Assessment of air pollutants concentrations

5.1 In order to determine applicable assessment methods for specific pollutants within each area, including zones and agglomerations, the concentrations of sulfur dioxide, nitrogen dioxide, particulate matter, ozone, lead, carbon monoxide and benzene shall be evaluated against the following thresholds:

- The upper assessment threshold, i.e. the 99th percentile pollutant levels represent a pollutant value exceeding 70 % of a limit value (taking into account limit values for all periods that have been used to derive averages).
- The lower assessment threshold, i.e. the 99th percentile pollutant levels represent a pollutant value below 50 % of all limit values (taking into account limit values for all periods that have been used to derive averages).

5.2 Provision is made for three air pollutants concentration assessment methods used in areas, including zones and agglomerations, based on the classification pollutants concentrations relative to the upper and lower assessment thresholds. These methods are

- a) mandatory monitoring, which may be supplemented by modelling techniques to provide an adequate level of information on ambient air quality. This method shall be implemented in areas where the upper assessment threshold for a specific pollutant is exceeded,
- b) a combination of measurement and modelling techniques that shall be implemented in areas and for pollutants for which concentrations are between the upper and lower assessment thresholds, and
- c) the sole use of modelling or objective estimation techniques; this is permissible in areas with and for pollutants concentration below the lower assessment threshold.

5.3 The classification of areas and agglomerations to determine applicable assessment methods shall be based on air pollutants concentrations recorded during the previous five years where sufficient data are available. Where fewer than five years' data are available, results from measurement campaigns of short duration during the period of the year and at locations likely to be typical of the highest pollution levels may be combined with information from emission inventories and modelling to provide the concentration data required. Classification should be reviewed earlier than every five years in the event of significant changes in activities relevant to ambient air pollutants concentrations.

5.4 Where pollutants have to be measured, the measurements shall be taken at fixed sites determined by appropriate assessment. The analyser can be permanent or movable, but in the case of movable analysers they shall monitor at each site for at least two weeks in every two-month period. The measurements shall be taken either continuously or by random sampling. The number of measurements shall be sufficiently large to enable the levels observed to be determined.

5.5 The criteria for determining the location of sampling points for the measurement of SO₂, NO₂, particulate matter (PM₁₀), O₃, Pb, CO and C₆H₆ in ambient air shall be those listed in annex A. The minimum number of sampling points for fixed measurements of concentrations of each relevant pollutant shall be as laid down in annex B and they shall be installed in each zone or agglomeration within which measurement is required, if fixed measurement is the sole source of data on concentrations within it.

NOTE See annex C for the compilation of results, and annex D for the setting of an annual limit value for C₆H₆.

5.6 Measurements of nitrogen dioxide shall be made at a minimum of 50 % of the ozone sampling points as required in B.2. Measurement of nitrogen dioxide shall be continuous, except at rural background stations, as defined in A.2, where other measurement methods may be used.

5.7 In the case of zones and agglomerations within which information from fixed measurement stations is supplemented by information from other sources, such as emissions, inventories, indicative measurement methods and air quality modelling, the number of fixed measuring stations to be installed and the spatial resolution of other techniques shall be sufficient for the concentrations of air pollutants to be established in accordance with A.1 and A.2, in consideration of data capture and time coverage (see 3.1.6 and 3.1.13, respectively).

5.8 In the case of zones and agglomerations within which information from sampling points for fixed measurement of ozone is supplemented by information from modelling or indicative measurement (or both), the number of sampling points specified in B.2 may be reduced, provided that:

- a) the number of sampling points in each zone or agglomeration amounts to at least one sampling point per two million inhabitants or one sampling point per 50 000 km², whichever produces the greater number of sampling points;
- b) each zone or agglomeration contains at least one sampling point; and
- c) nitrogen dioxide is measured at all remaining sampling points except at rural background stations.

5.9 In the case of zones and agglomerations within which measurement is not required, modelling or objective estimation techniques may be used.

5.10 The reference methods for the sampling and analysis of SO₂, NO₂, PM₁₀, O₃, Pb, CO and C₆H₆ shall be as given in the relevant clauses of this standard.

5.11 Any amendments necessary to adapt the assessment of air pollutants concentrations and annexes A to E to scientific and technical progress shall ensure that such adaptations do not have the effect of modifying the limit values or alert thresholds either directly or indirectly.

5.12 Each provincial authority shall ensure that at least one measuring station that supplies data on concentrations of the ozone precursor substances listed in annex E, is installed and operated within its province. Each province shall choose the number and siting of the station at which ozone precursor substances are to be measured, taking into account the objectives, methods and recommendations given in annex E.

5.13 The reference techniques for air quality modelling shall be as given in annex F.

6 Report and review

In order to facilitate the review of this standard the national authority will encourage research into the effects of the pollutants referred to herein, namely sulfur dioxide, nitrogen dioxide (and oxides of nitrogen), particulate matter, lead, carbon monoxide, ozone and benzene.

Amendments necessary for adaptation to scientific and technical progress may relate solely to criteria and techniques for the assessment of pollutants concentrations or detailed arrangements for forwarding information, and may not have the effect of modifying limit values or alert thresholds either directly or indirectly.

NOTE See annex G for air quality models.

Annex A
(normative)

**Location of sampling points for the measurement of
atmospheric pollutants in ambient air**

**A.1 Macroscale siting of SO₂, NO₂, PM₁₀, CO, C₆H₆ and Pb sampling
points**

A.1.1 Sampling points directed at the protection of human health shall be sited

- a) to provide data on the areas within zones and agglomerations where the highest concentrations of pollutants occur to which the population is likely to be directly or indirectly exposed for a period that is significant in relation to the period used to derive averages in the case of limit value(s), and
- b) to provide data on levels in other areas within the zones and agglomerations that are representative of the exposure of the general population.

A.1.2 Sampling points shall be sited to avoid measuring very small micro-environments in their immediate vicinity. As a guideline, a sampling point shall be sited to be representative of air quality in a surrounding area of not less than 200 m² at traffic-orientated sites and of several square kilometres at urban-background sites.

A.1.3 Sampling points should also, where possible, be representative of similar locations not in their immediate vicinity.

A.2 Macroscale siting of O₃ sampling points

The macroscale siting criteria in table A.1 shall be used to assess the exposure of specific populations.

A.3 Macroscale siting of dustfall sampling points

The number and location of samplers shall be sufficient to monitor dustfall at representative locations around the dust source, and will include monitors located at human residences and sensitive businesses, industrial or agricultural locations within a maximum distance of 2 km from the source boundary. Micro-surroundings of the samplers shall, where possible, comply with ASTM D1739.

Dustfall monitors may also be located within the boundaries of the industrial plant as defined by the legal, fenced boundaries of the enterprise, for industrial control purposes. Even when included in general environmental reports, these site-internal monitors shall not be evaluated against the dust deposition evaluation criteria stipulated in 4.11.1.

Table A.1 — Macroscale siting criteria for ozone

1	2	3
Type of station	Represented area ^a	Macroscale siting criteria
Urban	A few square kilometres	<ul style="list-style-type: none"> – Away from the influence of local emissions such as traffic, petrol stations, etc. – Vented locations where well mixed levels can be measured – Locations such as residential and commercial areas of cities, parks (away from the trees), main streets or squares with very little or no traffic, open areas characteristic of educational, sports or recreational facilities
Suburban	Some tens of square kilometres	<ul style="list-style-type: none"> – At a certain distance from areas of maximum emissions, downwind following the main wind direction during conditions favourable to ozone formation – Where populations located in the outer fringe of an agglomeration are exposed to high ozone levels – Where appropriate, some suburban stations also upwind of the area of maximum emissions, in order to determine the regional background levels of ozone
Rural	Sub-regional levels (a few square kilometres)	<ul style="list-style-type: none"> – Stations can be located in small settlements – Representative of ozone away from the influence of immediate local emissions such as those from industrial installations and roads – At open area sites, but not on high mountain tops
Rural background	Regional/national/continental levels (1 000 km ² to 10 000 km ²)	<ul style="list-style-type: none"> – Station located in areas with lower population density, far removed from urban and industrial areas and away from local emissions – Avoid locations that are subject to locally enhanced formation of near-ground inversion conditions, also summits of higher mountains – Coastal sites with pronounced diurnal wind cycles of local character are not recommended

^a Sampling points should also, where possible, be representative of similar locations not in their immediate vicinity.

A.4 Microscale siting of O₃, SO₂, NO₂, PM₁₀, CO, C₆H₆ and Pb sampling points

A.4.1 The following guidelines should be complied with as far as is practicable:

- The flow around the inlet sampling probe shall be unrestricted, without any obstructions affecting the airflow in the vicinity of the sampler (normally some metres away from buildings, balconies, trees and other obstacles and at least 0,5 m from the nearest building in the case of sampling points representing air quality at the building line).
- In general, the inlet sampling point shall be between 1,5 m (the breathing zone) and 4 m above the ground. Higher positions (up to 8 m) might be necessary in some circumstances. Higher siting might also be appropriate if the station is representative of a large area.
- The inlet probe shall not be positioned in the immediate vicinity of sources in order to avoid direct intake of emissions unmixed with ambient air.
- The sampler's exhaust outlet shall be positioned so that recirculation of exhaust air to the sample inlet is avoided.
- Location of traffic-orientated samplers:

- 1) for all pollutants, such sampling points shall be at least 25 m from the edge of major junctions and at least 4 m from the centre of the nearest traffic lane;
- 2) for nitrogen dioxide and carbon monoxide, inlets shall be not more than 5 m from the kerb;
- 3) for benzene, particulate matter and lead, inlets shall be sited so as to be representative of air quality near the building line.

A.4.2 The following factors can also be taken into account:

- a) interfering sources;
- b) security;
- c) access;
- d) availability of electrical power and telephone communications;
- e) visibility of the site in relation to its surroundings;
- f) safety of the public and operators;
- g) desirability of co-locating sampling points for different pollutants; and
- h) planning requirements.

A.5 Documentation and review of site selection

The site selection procedures shall be fully documented at the classification stage by such means as compass-point photographs of the surrounding area and a detailed map. Sites shall be reviewed at intervals and documentation updated to ensure that selection criteria remain valid over time.

In the case of ozone, the site review process requires proper screening and interpretation of the monitoring data in the context of the meteorological and photochemical processes affecting the ozone concentrations measured at the respective site.

Annex B
(normative)

**Criteria for determining the number of sampling points
for fixed measurement of concentrations of atmospheric
pollutants in ambient air**

**B.1 Minimum number of sampling points for fixed measurements to
assess compliance with SO₂, NO₂, PM₁₀, CO, C₆H₆ and Pb limit values**

B.1.1 Diffuse sources

In the case of areas polluted by NO₂, PM₁₀, C₆H₆ and CO in which the pollutant level exceeds the upper assessment threshold, at least one urban background station and one traffic-orientated station shall be included, provided this does not increase the number of sampling points (see table B.1).

**Table B.1 — Minimum number of sampling points for fixed measurements
to assess compliance with SO₂, NO₂, PM₁₀, CO, C₆H₆ and Pb limit values**

1	2	3	4
Population of agglomeration or zone (thousands)	Minimum number of sampling points		
	If concentrations exceed the upper assessment threshold ^a	If maximum concentrations are between the upper and lower assessment thresholds ^b	For SO ₂ and NO ₂ in agglomerations where maximum concentrations are below the lower assessment threshold ^c
0 - 249	1	1	not applicable
250 - 499	2	1	1
500 - 749	2	1	1
750 - 999	3	1	1
1 000 - 1 499	4	2	1
1 500 - 1 999	5	2	1
2 000 - 2 749	6	3	2
2 750 - 3 749	7	3	2
3 750 - 4 749	8	4	2
4 750 - 5 999	9	4	2
>6 000	10	5	3

^a Areas in which the 99th percentile pollutant levels represent a value exceeding 70 % of a limit value (taking into account limit values for all periods used to derive averages).

^b Areas in which the 99th percentile pollutant levels are between 50 % and 70 % of a limit value (taking into account limit values for all specified periods used to derive averages).

^c Agglomerations where the 99th percentile pollutant levels are below 50 % of all limit values (taking into account limit values for all specified average periods).

B.1.2 Point sources

For the assessment of pollution in the vicinity of point sources, the number of sampling points for fixed measurements shall be calculated taking into account emission densities, the likely distribution patterns of ambient air pollution and potential exposure of the population.

Sampling points for fixed measurements shall be sited in such a way that the samples taken will be representative of the exposure of the sampled population.

B.2 Minimum number of sampling points for fixed measurements to assess compliance with ozone limit values

Table B.2 — Minimum number of sampling points for fixed measurements to assess compliance with ozone limit values

1	2	3	4
Population of agglomeration or zone (thousands)	Minimum number of sampling points		
	Agglomerations (urban and suburban) ^a	Other zones (suburban and rural) ^a	Rural background
0 - 249	—	1	One station per 50 000 km ² as an average density over all zones within the country ^b
250 - 499	1	2	
500 - 999	2	2	
1 000 - 1 499	3	3	
1 500 - 1 999	3	4	
2 000 - 2 749	4	5	
2 750 - 3 749	5	6	
>3 750	One additional station per two million inhabitants	One additional station per two million inhabitants	
^a At least one station in suburban areas, where the highest exposure of the population is likely to occur. In agglomerations, at least 50 % of the stations should be located in suburban areas.			
^b One station per 25 000 km ² for complex terrain is recommended.			

Annex C
(informative)

**Data quality objectives and compilation of the results
of air quality assessments**

C.1 Data quality objectives

C.1.1 The following data quality objectives for allowed uncertainty of assessment methods, of minimum time coverage and of data capture of measurement are provided in table C.1 to guide quality assurance programmes.

Table C.1 — Data quality objectives per measuring station

1	2	3	4	5	6
Measurement	SO ₂ and NO ₂ %	PM ₁₀ and Pb %	O ₃ %	C ₆ H ₆ %	CO %
Fixed point, continuous measurements^a					
Uncertainty	15	25	15	25	15
Minimum data capture	90	90	90 (summer) 75 (winter)	90	90
Minimum time coverage				35 ^c 90 ^d	
Indicative measurements					
Uncertainty	25	50	30	30	25
Minimum data capture	90	90	90	90	90
Minimum time coverage	14 ^b	14 ^b	>10 (summer)	14 ^b	14 ^b
Modelling					
Uncertainty					
Hourly averages	50-60		50 (daytime)		50
8-hourly averages			50		
Daily averages	50	not yet defined			
Annual averages	30	50		50	
Objective estimation					
Uncertainty	75	100	75	75	75
^a Random measurements instead of continuous measurements may be applied for benzene if it can be demonstrated that the uncertainty, including the uncertainty due to random sampling, meets the quality objective of 25 %. Random sampling should be evenly distributed over the year in order to avoid skewing of results. ^b One day's measurement per week at random, evenly distributed over the year, or eight weeks evenly distributed over the year. ^c Urban background and traffic sites (distributed over the year to be representative of various conditions for climate and traffic). ^d Industrial sites.					

C.1.2 The uncertainty (on a 95 % confidence interval) of the measurement methods should be evaluated in accordance with the principles of ISO 5725-1, or equivalent. The percentages for uncertainty in table C.1 are given for individual measurements, averaged over the period for considered by the limit values, for a 95 % confidence interval (bias plus twice the standard deviation). The accuracy for continuous measurements should be interpreted as being applicable in the region of the appropriate limit value.

C.1.3 The uncertainty for modelling and objective estimation is defined as the maximum deviation of the measured and calculated concentration levels, over the period for calculating the appropriate threshold, without taking into account the time of the events.

C.1.4 The requirements for minimum data capture and time coverage do not include losses of data due to the regular calibration or normal maintenance of the instrumentation.

C.1.5 By way of derogation, random measurements may be applied instead of continuous measurements for particulate matter and lead if it can be demonstrated that accuracy within the 95 % confidence interval with respect to continuous monitoring is within 10 %. Random sampling should be spread evenly over the year.

C.2 Results of air quality assessments

The following information should be compiled for zones or agglomerations within which sources other than measurement are employed to supplement information from measurements or as the sole means of air quality assessment:

- a) a description of assessment activities carried out;
- b) the specific methods used, with references to descriptions of the methods;
- c) the sources of data and information;
- d) a description of results, including accuracies and, in particular, the extent of any area or, if relevant, the length of road within the zone or agglomeration over which concentrations exceed the limit value(s). Alternatively the limit value(s) plus applicable margin(s) of tolerance and of any area within which concentrations exceed the upper assessment threshold or the lower assessment threshold as given in clause 5;
- e) for the limit values, the object of which is the protection of human health, the population potentially exposed to concentrations in excess of the limit value; and
- f) where possible, maps should be compiled showing concentration distributions within each zone and agglomeration.

C.3 Standardization

For sulfur dioxide, nitrogen dioxide, benzene, carbon monoxide and ozone, the volumes should be standardized at a temperature of 25 °C and a pressure of 101,3 kPa.

Annex D
(informative)

Basis for setting an annual limit value for benzene

In proposing the limit value for benzene based on an annual average concentration for South Africa, there was a call to justify the adoption of the EU Guideline and in particular reference to the risk-based approach.

The reported acceptable risk level to be tolerated is in the range one in ten thousand to one in a million. The one in a million incremental cancer risk tends to have widespread use but its basis appears to be linked to arbitrary application by the US Food and Drug administration.

Taking the risk-based approach, it should be emphasized that risk determination should be justified using local data and the final risk profiles selected should be subjected to an overall risk management process subject to social, political and economic considerations. This approach has been justified in the WHO Air Quality Guidelines for Europe.

The limit value proposed for South Africa is based on the EC document *Council directive on ambient air quality assessment and management*: Working group on benzene: Position Paper, September 1998. The working group for organic volatile pollutants noted that, owing to the phasing out of lead in South African fuel by 2006 and the probable low proportion of motor vehicles that would be fitted with catalytic converters by that time, it is possible that ambient concentrations of benzene could increase from present (2003) levels (see chapter 5 in the position paper). The working group nevertheless concurred that exposure to benzene in ambient air should be as low as possible and that only an annual average limit value should be set.

In view of the uncertainties still associated with estimating the health risk due to benzene exposure, the working group for organic volatile pollutants concurred that the proposed limit of $5 \mu\text{g}/\text{m}^3$ implements the precautionary approach until such time as further studies provide more certainty. The working group was of the opinion that full implementation of the standard could not realistically be achieved in less than ten years.

Annex E (normative)

Measurements of ozone precursor substances

E.1 Objectives

The main objectives of measurements of ozone precursor substances are to analyse any trend in ozone precursors, to check the efficiency of emission reduction strategies, to check the consistency of emission inventories and to help attribute emission sources to pollution concentration.

An additional aim is to support the understanding of ozone formation and precursor dispersion processes, and also the application of photochemical models.

E.2 Substances

Measurement of ozone precursor substances shall include at least nitrogen oxides and appropriate volatile organic compounds (VOCs). A list of VOCs recommended for measurement is given in table E.1.

Table E.1 —Volatile organic compounds for measurement of ozone precursor substances

1	2	3	4
Volatile organic compounds			
Acetylene	Ethane	i-Octane	Toluene
Benzene	Ethylene	n-Octane	Total non-methane hydrocarbons
1.3-Butadiene	Ethyl benzene	i-Pentane	1,2,3-Trimethylbenzene
i-Butane	Formaldehyde	n-Pentane	1,2,4-Trimethylbenzene
n-Butane	n-Heptane	1-Pentene	1,2,5-Trimethylbenzene
1-Butene	i-Hexane	2-Pentene	m+p-Xylene
cis-2-Butene	n-Hexane	Propane	o-Xylene
trans-2-Butene	Isoprene	Propene	

E.3 Reference methods

The reference methods for the sampling and analysis of ozone precursor substances shall either be EPA Compendium method TO-14 A or method TO-17.

NOTE Any other method that can be demonstrated to give equivalent results may be used.

E.4 Siting

Measurements shall be taken in particular urban and suburban areas at any monitoring site considered appropriate with regard to the above monitoring objectives.

Annex F
(informative)

Target levels for PM₁₀, SO₂ and Pb

F.1 Objectives

Target levels are defined as aspirational levels based on current scientific knowledge, with the aim of minimizing or avoiding harmful effects on human health, wellbeing or the environment. The National Framework describes these as the ambient air quality levels that provide an adequate development buffer between air that is considered harmful and air that is not considered harmful to health and wellbeing. These levels may be regarded as limit values in future reviews of this standard, after taking into account all technical and socio-economic conditions.

F.2 Target levels

Target levels for PM₁₀, SO₂, and Pb are given in tables F.1 to F.3.

Table F.1 — Target level for PM₁₀

1	2	3
Exposure period	Average period	Target value µg/m ³
Daily limit value for the protection of human health	24 h	50
Annual limit value for the protection of human health	Calendar year	20

Table F.2 — Target level for SO₂

1	2	3
Exposure period	Average period	Target value µg/m ³
Daily limit value for the protection of human health	24 h	20
10 min limit value for the protection of human health	10 min	500

Table F.3 — Target level for Pb

	2	3
Exposure period	Average period	Target value µg/m ³
Annual limit value for the protection of human health	Calendar year	0,25

Annex G (informative)

The use of air quality models

G.1 Introduction

Air quality dispersion models are used to predict the ambient concentrations in air of pollutants emitted to the atmosphere from a variety of processes. The most common applications are those that simulate the emission of gaseous and particulate combustion products. Such models are widely used by environmental regulators and practitioners in the US, the UK, Europe, Australia and elsewhere to determine likely compliance with air quality limits.

Air quality modelling and monitoring should be seen as complementary activities. Monitoring can give accurate information about air quality at discrete points. The main disadvantages are that monitoring is generally expensive, and the results cannot necessarily be extrapolated to describe concentrations over a wide spatial domain. On the other hand, modelling can be relatively inexpensive and can cover a defined spatial domain. The disadvantages of modelling are in its inherent uncertainties with regard to the predicted concentrations and the necessity to obtain reasonably well-defined emission and meteorological data.

This guidance is intended for use by those tasked with air quality assessment and management for emissions from either existing or proposed sources. In the case of an application for an emissions license, it is important that the submitting organization and the regulatory authorities understand the limitations and applicability of the model or models being used. Thus the choice of model will be determined not only by the complexity of the situation being modelled but also by the ease with which the results can be assessed and adjudicated by the authorities on a case-by-case basis and the capacity of the authorities to do such assessments. The users should thus be trained and capacitated to undertake the necessary work, bearing in mind that the modelling environment is continuously developing, given the rapidly increasing availability of computer power and techniques. Finally, models should be compatible across the various processes needed to authorize operations. Thus, only one modelling submission should be needed for both environmental impact assessment purposes and the application for an emissions license.

This guidance does not represent a comprehensive set of criteria covering all possible considerations related to dispersion model selection and applications. Instead, it examines the applicability of different types of dispersion models under certain circumstances and sets the minimum requirements to promote the use of the best practice in the application of atmospheric dispersion models for compliance assessment purposes.

The intending applicant should discuss the specific application and agree to a particular modelling requirement with the regulatory authority based on a written protocol.

This protocol should include:

- a) the location of the applicant's sources;
- b) emission rates, source type, source release parameters;
- c) a discussion of the surrounding terrain and the effects it will have on pollutant dispersion, as applicable;
- d) the modelling analysis methodology, including the model(s) to be used in the analysis;

- e) the air quality monitoring data and location of air quality monitoring location(s) used in the analysis for model result verification, if applicable; and
- f) the type of meteorological data used in the analysis, as applicable.

G.2 Air quality model selection

G.2.1 A hierarchy of models of increasing complexity exists, ranging from simple empirical models, through screening models, which generally do not require site-specific meteorology, to advanced, refined models able to account for pollutant dispersion from multiple sources within complex terrain environments and complex meteorology. Other models that address specialized features of localized atmospheric dispersion are also available.

G.2.2 Several air quality models have been approved for regulatory use for specific applications in various countries. The use of such models is recommended given that these models have been developed using the large resources available in the developed world and, in many cases, are available free of charge as downloadable files. They are likely to have been subject to substantial evaluation studies and peer review; and the mathematics of the model, data requirements and programme operating characteristics are likely to be documented. They are also subject to a continuous process of review and update at no cost to users outside that country. However, it should not be construed that the models preferred or approved for use elsewhere should be used to the exclusion of all others or that they are the only models available for relating emissions to air quality.

G.2.3 The use of independently developed software in regulatory analyses is recognized. Such software should, however, have been evaluated and shown to be valid for the application for which it is being used. Such evaluation should include quality assurance planning, documentation and scrutiny consistent with the intended use. This scrutiny will include

- a) a scientific peer review,
- b) a supportive analysis (i.e. diagnostic evaluations, code verification, and a sensitivity and uncertainty analysis),
- c) diagnostic and performance evaluations with data obtained in trial locations, and
- d) statistical performance evaluation circumstances similar to the intended application

G.2.4 The user of a model should be able to justify the choice of any particular model, and demonstrate its “fitness for purpose”. Model users should be able to demonstrate that the model is suited to the following:

- a) the size of the modelling domain;
- b) the complexity of the terrain (includes potential for thermo-topographic and urban boundary layer effects);
- c) the nature of the sources; and
- d) the type of pollutant.

Complex terrain refers to uneven terrain, coastal environments or urban areas where the potential exists for thermo-topographically induced air circulations or urban boundary layer effects. Models applied in such environments should allow for spatial variations, i.e. wind, inversion break-up, fumigation and atmospheric stagnation.

G.3 Treatment of specific pollutants

Carbon monoxide (CO), nitrogen dioxide (NO₂), particulates (PM₁₀ and PM_{2.5}) and lead (Pb) are often associated with emissions from numerous sources. Several of these pollutants are also closely related to one another in that they share common sources of emission or are subject to chemical transformations of similar precursors, or both. It is therefore recommended that models be used that take into account the chemical coupling between relevant pollutants when appropriate and feasible. For example, fine particles in the PM_{2.5} range are typically comprised primarily of secondary particles formed through transformations of sulfur oxides (SO_x), nitrogen oxides (NO_x) and VOCs. The simulation of PM_{2.5} concentrations based exclusively on particulate emissions and neglecting the secondary components of PM_{2.5} such as sulfates and nitrates, will therefore result in an underestimation of actual PM_{2.5} concentrations.

The use of photochemical models is specifically recommended for the prediction of ozone concentrations. Such models need to consider emissions of VOC, NO_x and CO, and also a means for generating meteorological data governing transport and the dispersion of ozone and its precursors.

Where compliance to the dust deposition criteria of this standard is to be tested, the model(s) used should contain specific deposition algorithms.

G.4 Source data

G.4.1 Emission rates

Modelled emission rates should be representative of the average period(s) for which air pollution concentrations are being determined.

Temporal trends in emissions should be accounted for, with both normal and foreseeable upset emission rates being modelled.

G.4.2 Background concentrations

In the case of proposed sources, modelled concentrations should be added to existing background concentrations in order to evaluate the cumulative impact relative to the air quality limits. Such background concentrations might be determined from monitoring or modelling approaches, or from a combination thereof.

G.5 Receptor grids

The receptor grid should be able to delimit the areas of highest possible impact. In general, the receptor network may be considered adequate if the difference in concentration at neighbouring receptors is no larger than half the difference between the maximum modelled concentration and the air quality limit being considered. Thus,

$$C_1 - C_2 \leq 0,5(C_l - C_m)$$

where

C_1 and C_2 are concentrations at adjacent receptors 1 and 2;

C_l is the air quality limit;

C_m is the maximum modelled concentration at receptors 1 and 2.

The height of receptors should be appropriate to the purpose for which modelling is being carried out. For general air quality compliance modelling, a receptor height of 1,5 m is appropriate.

G.6 Terrain elevations

Simple terrain (terrain elevations below the level of pollutant release) and complex terrain (terrain elevations above the level of pollutant release) will need to be addressed in all modelling analyses if the terrain within the vicinity of the subject source is expected to have an effect on pollutant dispersion. Similarly, sensitive receiving environments might be elevated above ground level.

G.7 Meteorological data

G.7.1 Screening meteorological data

Screening models use a “worst-case” meteorological data set. Such data sets allow such models to simulate a full set of atmospheric conditions to calculate the highest possible concentration which, in some cases, may be sufficient in terms of the application. Worst-case meteorological data should only be used in a refined screening model for compliance analysis purposes, and only if a representative actual meteorological data set is not available. Only 1 h concentrations can be calculated using a worst-case meteorological data set. For other average periods, impacts should be calculated by the application of appropriate time-scaled conversion factors.

G.7.2 Representative meteorological data

Where available, actual meteorological data should be used in a refined modelling analysis. If on-site data are not available for modelling, representative data collected from another meteorological site may be used, subject to qualification in terms of quality assurance and such data being shown to be adequately representative of the site being modelled. To demonstrate representativeness, an analysis should be undertaken comparing the physiographic and meteorological parameters of the data site.

Where available, five years of valid meteorological data should be used. A minimum of one year of valid data should be used.

G.8 Time average periods

Air pollutants concentrations should be predicted for the same average period for which air quality limits are provided. Should such limits refer to running averages rather than block averages, the dispersion model outputs should reflect such values.

Most dispersion models are only able to simulate pollutant concentrations for a one-hourly or longer average period. In order to use such models to demonstrate compliance with air quality limits for shorter average periods, reference can be made to reported concentration ratios between different average periods. Although this is a function of both source configuration and atmospheric turbulence, it can generally be shown that concentrations obtained over different average times are related as follows:

$$C_1/C_2 = (T_2/T_1)^p$$

where

C_1 and C_2 are concentrations for average times T_1 and T_2 , respectively;

T_1 and T_2 are any two average times;

p is a parameter ranging from 0,16 to 0,68, depending on the atmospheric stability.

The most widely used values for p range between 0,16 and 0,25. Where a locally validated value is not available, a value of 0,2 is recommended.

G.9 Building downwash

Airflow over and around buildings and other solid structures might restrict the dispersion of a pollutant source. When modelling release points where the release height is less than good engineering practice (GEP), the effects of building downwash should be addressed in the modelling analysis.

G.10 Quantification of model uncertainty

Any dispersion model will always have a degree of error due to unavoidable inaccuracies in the recorded meteorological data and the simplifications made in the model algorithms for atmospheric processes. In addition, atmospheric mixing has an inherent degree of randomness, owing to the turbulent flows that occur. It is for this reason that models are required to be performance tested and their degree of uncertainty specified. If a model is used for compliance demonstration, the model uncertainty should be quantified and communicated to the decision-makers.

G.11 Validation protocols

The application of air quality models for air pollution control strategy analysis should include calibration and evaluation against quality monitoring data. Only models that have been verified by past data should be used for future forecasting. Modelled and monitored concentrations should be compared for the same average period. The generation of curves indicating the frequency by which modelled and monitored concentrations exceed the permissible values provides a more effective basis for comparison than does a simple comparison of maximum and mean period averages. Any corrections made to the model during its validation should be clearly documented and identified.

A standard validation protocol should be used for model evaluation. Examples of such protocols are:

- *Protocol for determining the best performing model.* US EPA report EPA-454/R-92-025.
- European initiative on *harmonisation within atmospheric dispersion modelling for regulatory purposes.*
- *Atmospheric dispersion modelling: guidelines on the justification and use of models, and the communication and reporting of results.*

These evaluation protocols include the validation steps enumerated for independently developed models given in G.2.

Table G.1 — Air quality model selection

1	2	3	4	5
Model	Advantages	Disadvantages	Availability	Suitability for regulatory purposes
Empirical	<p>Very easy to use once it has been set up.</p> <p>Setting up the model requires only moderate data intensity.</p> <p>Needs no prior assumptions regarding the local validity of dispersion characteristics.</p> <p>Needs little data.</p>	<p>Requires observed data up-front for emissions, ambient air quality and meteorology.</p> <p>Site specific.</p> <p>Plant specific.</p> <p>Process specific.</p> <p>No theoretical basis.</p> <p>Short range only.</p>	<p>Local data exist for model formulations but may not be made available in all cases.</p>	<p>Low</p>
Screening	<p>Very easy to use.</p> <p>Gives a wide range of predictions that can be easily matched to expected operational conditions.</p> <p>Can incorporate:</p> <ul style="list-style-type: none"> • plume rise due to momentum and buoyancy; • plume reflection from ground and top of the mixing height; and • stack-top downwash effects. <p>Uses well-tested and documented dispersion parameters.</p> <p>Can be used for scoping environmental impact assessments.</p> <p>Short and medium ranges.</p>	<p>Single source only.</p> <p>Cannot readily incorporate:</p> <ul style="list-style-type: none"> • instantaneous releases; • complex terrain^a and associated thermal effects; • low wind speeds; • changing dispersion characteristics with height; • dispersion in layered atmospheres; and • chemical reactions and removal processes. <p>Needs moderate meteorological understanding if used for convective boundary layer calculations.</p> <p>Often overly conservative.</p>	<p>Widely available as downloadable files.</p>	<p>High for screening assessment of isolated, single sources against short-term (24 h and lower) standards.</p>
<p>^a Complex terrain refers to uneven terrain, coastal environments or urban areas where the potential exists for thermo-topographically induced air circulations or urban boundary layer effects. Models applied in such environments should allow for spatial variations in wind, inversion break-up fumigation and atmospheric stagnation during calm wind periods.</p>				

Table G.1 (*continued*)

1	2	3	4	5
Model	Advantages	Disadvantages	Availability	Suitability for regulatory purposes
Gaussian Plume	<p>Used by many regulatory agencies worldwide.</p> <p>Relatively easy to use.</p> <p>Can incorporate:</p> <ul style="list-style-type: none"> • plume rise due to momentum and buoyancy; • diffusion; • deposition; • plume reflection from ground and top of the mixing height; • stack-top downwash and building wake effects; • various average periods; • the calculation of spatial distribution of ground level pollutants concentrations and deposition rates; • the calculation of pollutants concentration isopleths; and • intermittent releases. <p>Uses well-tested and documented dispersion parameters.</p> <p>Fairly good to moderate data intensity.</p> <p>Short and medium ranges.</p>	<p>Cannot readily incorporate:</p> <ul style="list-style-type: none"> • realistic wind fields; • instantaneous releases; • complex terrain and associated thermal effects; • low wind speeds; • changing dispersion characteristics with height; • dispersion in layered atmospheres; and • chemical reactions and removal processes. <p>Needs expert meteorological understanding if used for convective boundary layer calculations.</p> <p>Often overly conservative.</p>	<p>Some good examples are available as downloadable files.</p> <p>Commercial schemes are available.</p>	<p>High for multi-source situations and air quality management planning in non-complex terrain and for short to medium ranges.</p>

Table G.1 (concluded)

1	2	3	4	5
Model	Advantages	Disadvantages	Availability	Suitability for regulatory purposes
Gaussian Puff	<p>Can incorporate:</p> <ul style="list-style-type: none"> • realistic wind field simulations including low wind conditions; • various average periods; • the calculation of spatial distribution of ground level pollutants concentrations and deposition rates; • the calculation of pollutants concentration isopleths; and • complex terrain. <p>• Complex terrain, including street canyon and urban boundary layer effects.</p> <p>Uses well-tested and documented chemical transformation mechanisms.</p> <p>Input of emissions for a range of diverse source types.</p> <p>Medium and regional scale.</p>	<p>Often very data intensive.</p> <p>Requires detailed meteorological data.</p> <p>Requires specialist meteorological expertise to prepare meteorological input data required.</p>	<p>Some good examples are available as downloadable files and commercial schemes are available.</p>	<p>Low for non-complex terrain and short to moderate range applications.</p> <p>High for multi-source situations and air quality management planning in complex terrain environments.</p> <p>High for regional assessments.</p> <p>VOC, NO_x and CO, and also a means for generating meteorological data governing transport and dispersion of ozone and its precursors.</p>

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EPA Compendium Method TO-17, Determination of volatile organic compounds in ambient air using active sampling onto sorbent tubes. Available at <http://www.epa.gov/ttn/amt1/files/ambient/airtox/to-17r.pdf>

European initiative on harmonisation within atmospheric dispersion modelling for regulatory purposes. Available at <http://www.harmo.org/#ToC20>

The Model Validation Kit can be obtained from: H.R. Olesen, National Environmental Research Institute, P.O. Box 358, DK-4000 Roskilde, Denmark Tel. +45 46 30 12 00, Fax. +45 46 30 11 14. E-mail: hro@dmu.dk or http://www.dmu.dk/atmosphericenvironment/Harmoni/M_V_KIT.htm

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